Busseron Creek Watershed
TMDL Development

DRAFT

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Prepared for
Indiana Department of Environmental Management

Prepared by
Tetra Tech

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1.0 INTRODUCTION

The Busseron Creek watershed drains approximately 235 square miles of primarily agricultural and forested land in southwestern Indiana. A majority of the watershed is located in Sullivan County with smaller portions in Clay, Greene and Vigo counties (Figure 1). Tributaries to Busseron Creek include Sulpher Creek, Mud Creek, Big Branch, Kettle Creek, Buttermilk Creek and Robbins Creek. Indiana's 2006 Clean Water Act Section 303(d) list of impaired waters includes ten waterbody segments in the Busseron Creek watershed that were considered impaired due to heavy metals, sulfates, low dissolved oxygen, and total dissolved solids (TDS). The listings and causes of impairment have been adjusted as a result of this study and the updated information is shown in Table 1.

The Clean Water Act and U.S. Environmental Protection Agency (EPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) lists. A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the Busseron Creek watershed were to:

- Further assess the water quality of the Busseron Creek watershed and identify key issues associated with the impairments and potential pollutant sources.
- Use the best available science to determine the maximum load of the pollutants of concern that the streams can receive and still fully support all of their designated uses.
- Use the best available science to determine current loads and sources of the pollutants of concern. If current loads exceed the maximum allowable load, determine the load reduction that is needed.
- Identify feasible and cost-effective actions that can be taken to reduce loads.
- Inform and involve the stakeholders throughout the project to ensure that key concerns are addressed and the best available information is used.
- Submit a final TMDL report to USEPA for review and approval.

This project was implemented in the following phases:

1) The first phase involved the compilation and review of all the historical data and an identification of any data gaps necessary for the completion of TMDLs.
2) The second phase involved the collection of additional data to fill the identified gaps. IDEM collected additional water chemistry at 25 monitoring locations from August 22 through December 12, 2006 and the U.S. Geological Survey collected additional fish and water chemistry data from September 17 to 19, 2007.
3) The third phase involved the review and assessment of the collected data to make a final determination on the most likely causes of impairment. A number of factors were considered during this step, including a better understanding of the extent of the biological impairment in the watershed as well as the proposed change to Indiana's water quality standards for sulfate.
4) The final phase of the project was to calculate the allowable loads of the pollutants confirmed as causing impairments and to allocate those loads to the appropriate sources.

This report describes the entire analysis and, once finalized, will be submitted to EPA for approval as required by the Clean Water Act.

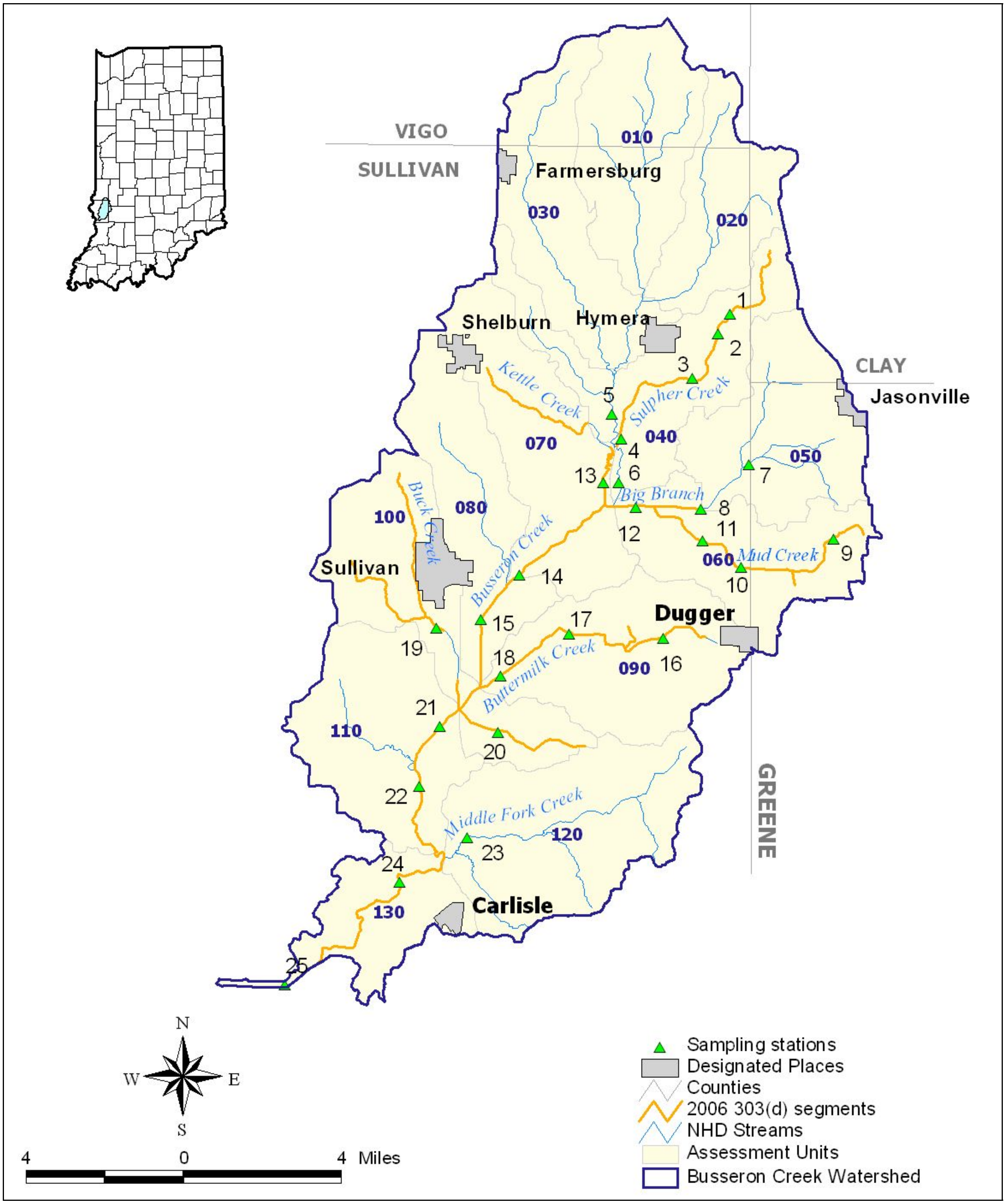

Figure 1. Location of the Busseron Creek Watershed and IDEM 2006 sampling stations.

Table 1. 2006 303(d) List Information for the Busseron Creek Watershed. Note that IDEM is in the process of re-segmenting several waterbodies for the 2008 list.

Waterbody	Segment ID	2006 Section 303 (d) Cause(s) of Impairment	Updated Cause(s) of Impairment
Big Branch - Mud Creek	INB11G6_00	Sulfates Total Dissolved Solids	Impaired Biotic Communities Iron Aluminum Dissolved Oxygen[1] pH[1] Total Suspended Solids
Big Branch Tributary - Gilmour	INB11G5_00	Sulfates Total Dissolved Solids	Aluminum Impaired Biotic Communities
Busseron Creek	INB11G8_T1036	Sulfates Total Dissolved Solids	Impaired Biotic Communities
	INB11G4_00	(Does not appear on 2006 list.)	Aluminum Impaired Biotic Communities Iron
Busseron Creek - Hymera	INB11G7_T1035	Sulfates Total Dissolved Solids	Phosphorus Dissolved Oxygen Impaired Biotic Communities Total Suspended Solids
Busseron Creek - Paxton	INB11GB_T1037	Sulfates Total Dissolved Solids	Impaired Biotic Communities
Busseron Creek - Tanyard Branch	INB11GD_00	Sulfates Total Dissolved Solids	
Buttermilk Creek	INB11G9_00	Sulfates Total Dissolved Solids	Aluminum Impaired Biotic Communities Total Suspended Solids Iron
Kettle Creek	INB11G7_00	Dissolved Oxygen	Phosphorus
Robbins Creek	INB11GA_00	Nutrients	Impaired Biotic Communities Phosphorus Dissolved Oxygen[1]
Sulpher Creek	INB11G4_T1024	Copper Nickel Zinc Sulfates Ph Biotic Communities Low Dissolved Oxygen Total Dissolved Solids	Aluminum Copper Impaired Biotic Communities Iron pH Phosphorus Manganese Total Suspended Solids Zinc

[1]Impairment based on data collected by USGS or IDNR (Appendix A).

2.0 DESCRIPTION OF THE WATERSHED

The Busseron Creek watershed lies within the greater Lower Wabash watershed and flows to the southwest for about 30 miles before discharging into the Wabash River west of Carlisle. A large part of the watershed lies in Sullivan County which covers approximately 82 percent of the watershed (Figure 1). The remaining portions of the watershed lie in Greene (7.75%), Vigo (6.65%), and Clay (3.48%) counties. Incorporated cities within the watershed include Farmersburg, Shelburn, Sullivan, Hymera, Dugger, Carlisle and Jasonville. The watershed is subdivided into the following 13 smaller subwatersheds:

- Busseron Creek (Hydrologic Unit Code (HUC 05120111160010)
- East Fork Busseron Creek (HUC 05120111160020)
- West Fork Busseron Creek (HUC 05120111160030)
- Sulpher Cree(HUC 05120111160040)
- Kettle Creek (HUC 05120111160070)
- Big Branch Headwaters (HUC 05120111160050)
- Busseron Creek-Morrison (HUC 05120111160080)
- Mud Creek (HUC 05120111160060)
- Busseron Creek-Buck/Robbins Creek (HUC 05120111160100)
- Buttermilk Creek (HUC 05120111160090)
- Busseron Creek-Paxton (HUC 05120111160110)
- Middle Fork Creek (HUC 05120111160120)
- Busseron Creek-Tanyard Branch (HUC 05120111160130

The following sections of this report provide information on the population, land uses, topography, and hydrology of the watershed.

2.1 Population

The population of the Busseron Creek watershed is not directly available but was estimated at approximately 15,400 based on U.S. Census data and the size of the watershed (Table 2). Sullivan, with a population of 4,617, is the largest community in the watershed.

Table 2. Population data for counties within the Busseron Creek Watershed

County	Total watershed population	% of total population	Non-urban Population	Urban Population
Clay	611	3.80	611	0
Greene	1347	8.36	491	856
Sullivan	9456	58.82	1478	7978
Vigo	4000	29.01	4000	0
Total	15414	100	6580	8834

Percentages are a proportion of the total watershed population.
Source: U.S. 2000 Census and geographic information system (GIS) analysis.

2.2 Topography and Soils

The Busseron Creek watershed is located in the Wabash Lowland physiographic region which is characterized by a broad lowland tract having an average elevation of 500 feet. The watershed is underlain by siltstone and shale of Pennsylvanian age and is comprised of extensive aggraded valleys and pockets of thick lacustrine, outwash, and alluvial sediments (USGS, 1983). Most soils in the watershed are classified as poorly draining C and D soils (61% and 6%, respectively), followed by moderately draining B soils (33%). Figure 2 shows the general topography within the watershed and indicates that elevations range from 415 to 677 feet with an average slope throughout the watershed of 5.4 ft per mile.

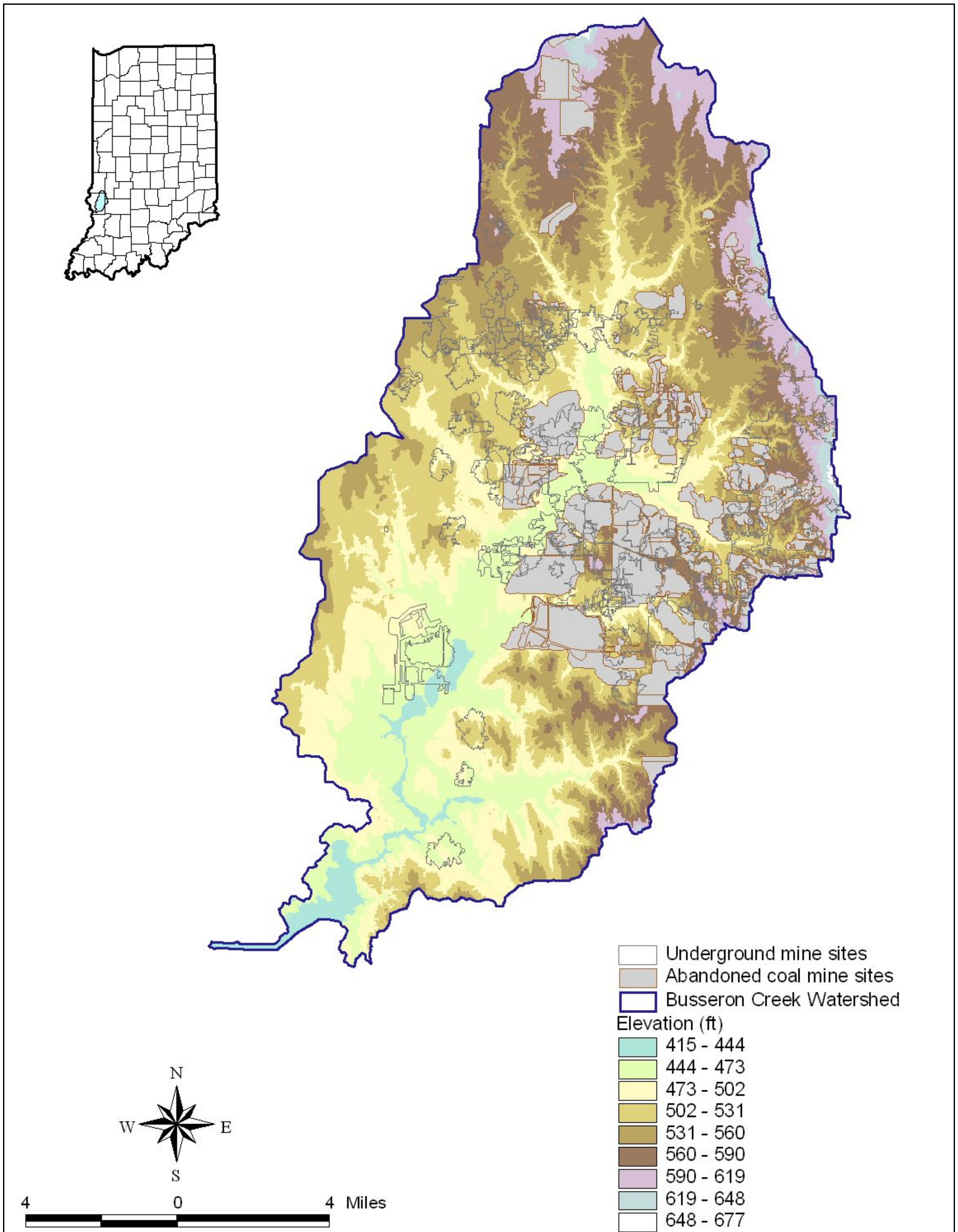

Figure 2. Topography and Mine Coverage in the Busseron Creek Watershed.

2.3 Land Use

Land use information for the Busseron Creek watershed is available from the Multi-Resolution Land Characteristics Consortium (MRLC). These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery from circa 2000. Figure 3 displays the spatial distribution of the land uses and the data are summarized in Table 3. A majority of the land (65 percent) is classified as agricultural with row crops accounting for 44 percent of the watershed followed by pasture and grasslands at 20 percent. Another 20 percent of the watershed is comprised of forest land, some of which is re-vegetated abandoned mine lands.

Approximately 34 square miles (15 percent) of the watershed is comprised of abandoned surface mine sites, primarily concentrated in the eastern part of Sullivan County (Figure 2). In addition, 48 square miles of the watershed (23 percent) is underlain by underground mines (Figure 2).

Table 3. Land Use and Land Cover in Busseron Creek Watershed.

Land Use/Land Cover	Watershed		
	Area		Percent
	Acres	Square Miles	
Developed	1332	2.08	0.88
Urban: high density	486	0.76	0.32
Urban: low density	1931	3.02	1.27
Agriculture: row crop	66952	104.61	44.25
Agriculture: pasture and grasslands	30839	48.19	20.38
Deciduous woodland	2371	3.7	1.56
Deciduous forest	31312	48.93	20.69
Evergreen forest	1083	1.69	0.71
Mixed Evergreen Deciduous forest	1625	2.54	1.07
Deciduous forest floodplain and bogs	8263	12.91	5.46
Deciduous woodland	119	0.19	0.07
Deciduous shrubland	1103	1.72	0.72
Herbaceous	300	0.47	0.19
Sparsely Vegetated/Unvegetated	16.45	0.03	0.01
Water bodies	3604	5.63	2.38
Total	**151,336.45**	**236.48**	**100**

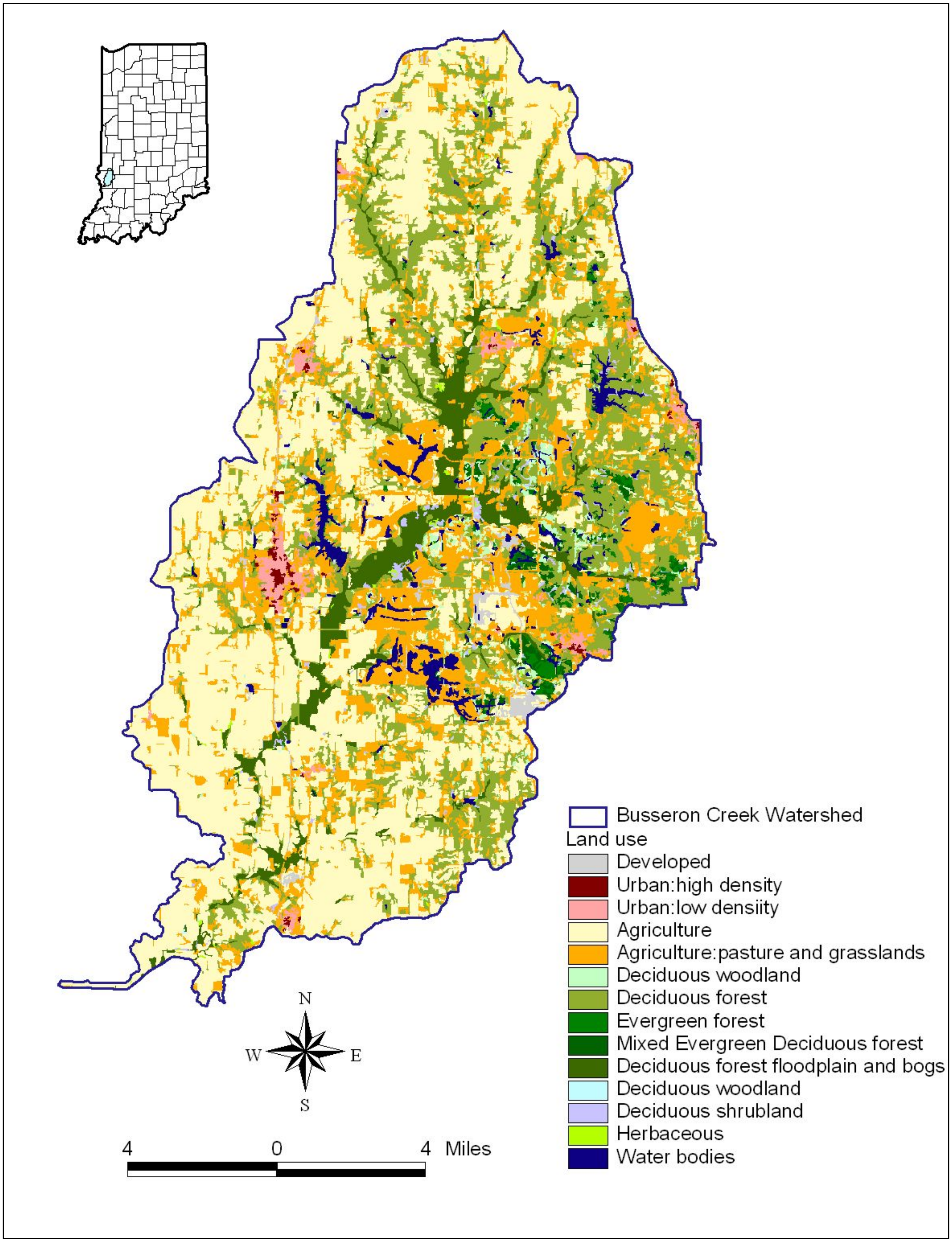

Figure 3. Land Use in the Busseron Creek Watershed.

2.4 Hydrology

There is one active (03342500) USGS flow gaging station on Busseron Creek located near Carlisle. The average daily flows for this gage from the period 1970 to 2007 are shown in Figure 4 and indicate that flows are typically the greatest during winter and spring (December through April) and least during late summer and fall (August through October).

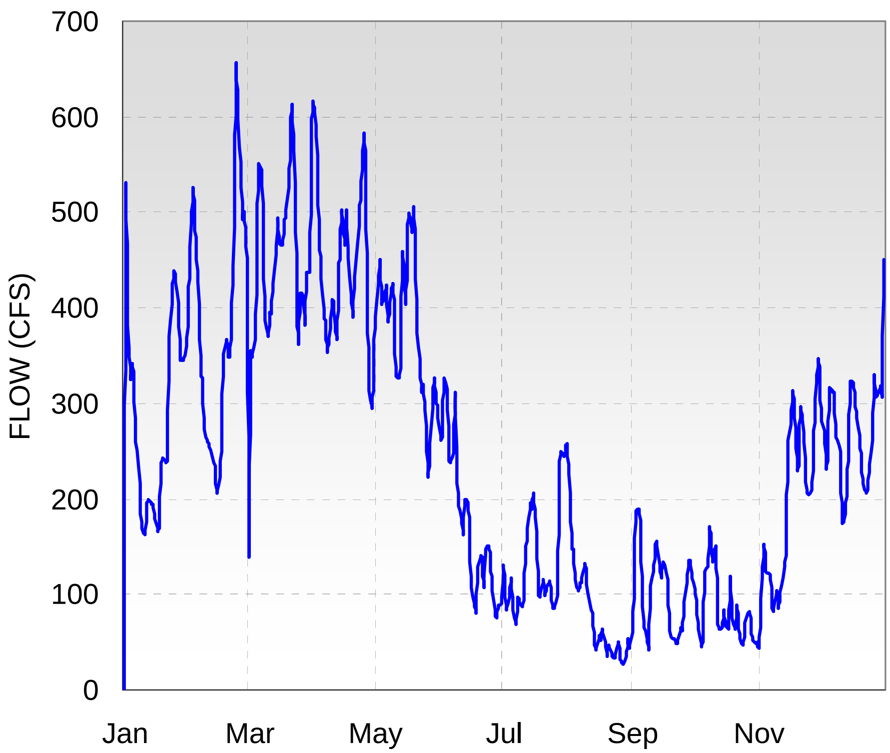

Figure 4. Average Daily Flow at Busseron Creek near Carlisle, IN, USGS Station 03342500 (1970 to 2007).

3.0 INVENTORY AND ASSESSMENTOF WATER QUALITY INFORMATION

This section of the report provides information on the water quality standards that apply to the impaired streams in the Busseron Creek watershed and provides a summary of existing water quality.

3.1 Water Quality Standards and TMDL Target Values

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the Clean Water Act's goal of "swimmable/fishable" waters. Water quality standards consist of several different components:

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters.
- Criteria express the condition of the water that is necessary to support the designated uses. **Numeric criteria** represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. **Narrative criteria** are the general water quality criteria that apply to all surface waters. These criteria state that all waters must be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal or aquatic life; and nutrients in concentrations that may cause algal blooms

Target values are needed for the development of TMDLs because of the need to calculate allowable daily loads. For parameters that have numeric criteria, the criteria are used as the TMDL target value. For parameters that do not have numeric criteria, target values must be identified from some other source. Table 4 describes the target values used for the Busseron Creek watershed TMDLs along with an explanation of how they were derived.

Table 4. Target values used for development of the Busseron Creek watershed TMDLs.

Parameter	Target Value	Source
Total phosphorus	No value should exceed 0.30 mg/L	This is a benchmark used by IDEM to interpret the narrative nutrient criteria (327 IAC 2-1-6).
pH	No pH values should be below six (6.0) or above nine (9.0), except daily fluctuations that exceed pH nine (9.0) and are correlated with photosynthetic activity, shall be permitted.	Numeric Criteria (327 IAC 2-1-6)
Dissolved Oxygen	Concentrations of dissolved oxygen shall average at least five (5.0) milligrams per liter per calendar day and shall not be less than four (4.0) milligrams per liter at any time.	Numeric Criteria (327 IAC 2-1-6)
Iron	No value should exceed 2.5 mg/L	This is a benchmark developed by IDEM based on aquatic toxicity testing for fish species native to the state.
Aluminum	No value should exceed 0.75 mg/L	This is the acute criterion recommended by EPA (53FR33178).
Total Suspended Solids	No value should exceed 30 mg/L	This is a benchmark used by IDEM to interpret the narrative sediment criteria (327 IAC 2-1-6).
Copper	AAC (µg/L) = WER ($e^{(0.9422[\ln(hardness)]-1.464)}$) Conversion factor = 0.96 CAC (µg/L) = WER ($e^{(0.8545[\ln(hardness)]-1.465)}$) Conversion factor = 0.96	Numeric Criteria (327 IAC 2-1-6)
Zinc	AAC (µg/L) = WER ($e^{(0.8473[\ln(hardness)]+0.8604)}$) Conversion factor = 0.978 CAC (µg/L) = WER ($e^{(0.8473[\ln(hardness)]+0.7614)}$) Conversion factor = 0.986	Numeric Criteria (327 IAC 2-1-6)
Manganese	AAC (µg/L) = ($e^{(0.8784[\ln(hardness)]+2.992)}$) CAC (µg/L) = ($e^{(0.8784[\ln(hardness)]+2.226)}$)	Numeric Criteria (327 IAC 2-1-6)

Notes: AAC = Acute Aquatic Criterion; CAC = Chronic Aquatic Criterion.
For copper, zinc and manganese equations are applied to determine water quality standards because the standards vary by hardness. Dissolved criteria for each of these parameters are computed by multiplying the AAC and CAC by the corresponding conversion factor. The total criterion was also used to determine dissolved metal violations to ensure that the dissolved metals meet the total criteria as well.

3.2 Assessment of Water Quality

This section provides a summary of the existing water quality of the Busseron Creek watershed.

3.2.1 Biological Data

Sampling performed by USGS in September 2007 documented widespread biological impairments in the Busseron Creek watershed as summarized in Table 5. Several potential reasons for the widespread impairments were identified through the TMDL effort including:

- Salts may be coming to the surface and then washing off during storm events which causes pH to drop to very low levels (0-2).
- The oxidation of iron may be consuming large amounts oxygen which in turn stresses fish and other aquatic organisms.
- Various metals, especially iron and aluminum, and other pollutants may be present at high enough concentrations as to be toxic to aquatic life.

The TMDL focuses on the last potential hypothesis but acknowledges that the first two may also be important and should be considered during the selection of implementation activities.

Table 5. Impaired Biotic Community Stream Segments in the Busseron Creek Watershed Identified During September 2007 USGS Sampling.

Stream	Score	Sampling Site	IBI Integrity Class
Sulfur Creek	12	2	Very Poor
Busseron Creek	20	5	Very Poor
Busseron Creek	42	6	Fair
Big Branch	28	7	Poor
Big Branch	14	8	Very Poor
Mud Creek	12	9	Very Poor
Mud Creek	16	11	Very Poor
Big Branch	18	12	Very Poor
Busseron Creek	24	14	Very Poor
Busseron Creek	22	15	Very Poor
Buttermilk Creek	28	16	Poor
Buttermilk Creek	36	18	Poor
Buck Creek	16	19	Very Poor
Robbins Branch	36	20	Poor
Busseron Creek	22	22	Very Poor
Busseron Creek	46	25	Fair

Notes: IBI = Index of Biotic Integrity. Scores calculated IDEM's *Summary of Protocols: Probability Based Site Assessment*. (IDEM, 2005).

3.2.2 Chemistry Data

Table 6 summarizes the water chemistry data within the Busseron Creek watershed by displaying the maximum concentrations at all impaired stations along with the reduction needed to meet the TMDL target values. The percent reductions were calculated as follows:

$$\% \text{ Reduction} = \frac{(\text{Target Value} - \text{Average})}{\text{Average}}$$

The table indicates the following:

- Large reductions are needed to meet the TMDL target values for aluminum, copper, iron, TSS, and zinc in Sulpher Creek.
- Large reductions are needed to meet the TMDL target values for aluminum and iron in Mud Creek.
- Relatively moderate reductions are needed to meet the TMDL target value for phosphorus in Sulpher, Kettle, and Robbins Creeks.

- Only one segment of Busseron Creek, INB11G4_00 located south of Hymera, is impaired (aluminum and iron).

Appendix B shows the individual sample results and statistical summaries for all 25 monitoring stations.

Table 6. Summary of water chemistry data within the Busseron Creek watershed.

Stream Name	Segment (Station)	Aluminum		Copper		Iron		Manganese		Phosphorus		TSS		Zinc	
		Maximum (µg/L)	Reduction	Maximum (µg/L)	Reduction	Maximum (µg/L)	Reduction	Maximum (µg/L)	Reduction	Maximum (mg/L)	Reduction	Maximum (µg/L)	Reduction	Maximum (µg/L)	Reduction
Sulpher Creek	INB11G4_T1024 (1)	14600	94%	No TMDL		32400	92%	No TMDL		0.5	40%	No TMDL		1430	83%
	INB11G4_T1024 (2)	13500	94%	No TMDL		35900	93%	No TMDL		1.16	74%	150	80%	1070	83%
	INB11G4_T1024 (3)	19700	96%	43.4	73%	23600	89%	1560	67	1.04	71%	No TMDL		632	83%
	INB11G4_T1024 (4)	1800	58%	No TMDL		No TMDL		No TMDL		No TMDL		No TMDL		No TMDL	
Busseron Creek	INB11G4_00 (5)	4010	81%	No TMDL		3310	24%	No TMDL		No TMDL		No TMDL		No TMDL	
Mud Creek	INB11G6_00 (9)	4790	94%	No TMDL		4370	42%	No TMDL		No TMDL		No TMDL		No TMDL	
	INB11G6_00 (10)	36800	97%	No TMDL		69800	96%	No TMDL		No TMDL		61	50%	No TMDL	
	INB11G6_00 (11)	10300	92%	No TMDL		29300	91%	No TMDL		No TMDL		No TMDL		No TMDL	
Big Branch	INB11G6_00 (12)	868	13%	No TMDL		5500	54%	No TMDL		No TMDL		No TMDL		No TMDL	
Kettle Creek	INB11G7_T1035 (13)	No TMDL		No TMDL		No TMDL		No TMDL		1.76	82%	296	89%	No TMDL	
Buttermilk Creek	INB11G9_00 (16)	1020	26%	No TMDL		No TMDL		No TMDL		No TMDL		60	50%	No TMDL	
	INB11G9_00 (17)	2680	72%	No TMDL		11800	78%	No TMDL		No TMDL		41	26%	No TMDL	
Robbins Creek	INB11GA_00 (19)	No TMDL		No TMDL		No TMDL		No TMDL		0.6	50%	114	73%	No TMDL	
	INB11GA_00 (20)	No TMDL		No TMDL		No TMDL		No TMDL		0.5	40%	No TMDL		No TMDL	

3.2.3 Sulfates and Total Dissolved Solids Listings

As shown in Table 1 several waterbody segments within the Busseron Creek watershed were listed as impaired due to sulfates and total dissolved solids on the 2006 Section 303(d) list. No TMDLs were developed for these parameters because of the following:

- Sulfates – IDEM is in the process of modifying its sulfate criteria and the proposed criteria would not result in any waterbodies within the Busseron Creek watershed being considered impaired.

- Total Dissolved Solids – Indiana's revised water quality standards no longer contains a water quality criterion for this parameter.

4.0 SOURCE ASSESSMENT

This section summarizes the available information on significant sources of the pollutants of concern in the Busseron Creek watershed.

4.1 Permitted Point Sources

The term point source refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term “point source” also includes: concentrated animal feeding operations (which are places where animals are confined and fed); storm water runoff from Municipal Separate Storm Sewer Systems (MS4s); and illicitly connected “straight pipe” discharges of household waste.

4.1.1 Wastewater Treatment Plants (WWTPs) and Industrial Facilities

Facilities with National Pollutant Discharge Elimination System (NPDES) permits to discharge wastewater within the Busseron Creek watershed include small to large publicly owned wastewater treatment facilities as well as industrial dischargers. There are 19 NPDES facilities within Busseron Creek watershed (Figure 7 and Table 7). The seven WWTPs in the watershed are potential sources of nutrients and the various industrial dischargers associated with mining activities are potential sources of TSS and metals. Table 8 summarizes permit violations for several of the facilities in the watershed and indicates there have a fair amount of violations, especially for TSS.

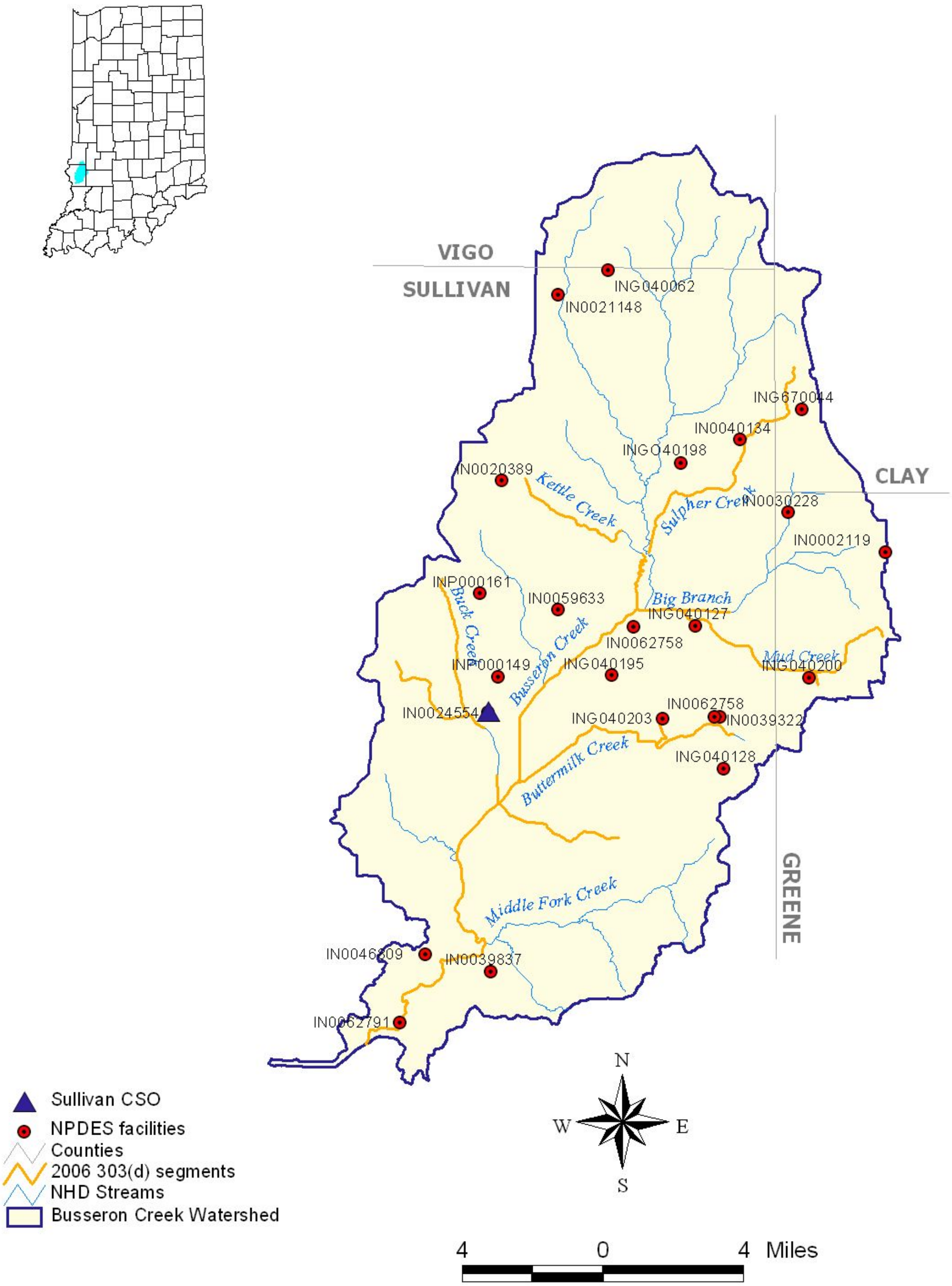

Figure 5. Location of NPDES Facilities in the Busseron Creek Watershed.

Table 7. NPDES Permitted Wastewater Dischargers within the Busseron Creek Watershed

Facility	Permit Number	Receiving Stream
Shakamak State Park WWTP	IN0030228	Big Branch Creek
Hymera Municipal WWTP	IN0040134	Sulpher Creek
Sullivan Municipal WWTP	IN0024554	Busseron Creek via Buck Creek
Allomatic Products	INP000149	Sullivan POTW
North American Latex Corp	INP000161	Sullivan POTW
Shelburn WWTP	IN0020389	Unnamed Tributary to Kettle Creek
Dugger WWTP	IN0039322	Buttermilk Creek
Carlisle WWTP	IN0039837	Busseron Creek
Town of Carlisle Water Department	IN0046809	Unnamed Ditch to Busseron Creek
Latta Indiana Diesel House	IN0002119	Busseron Creek via Big Branch
Glendora Test Facility	IN0059633	Unnamed ditch to Busseron Creek
Farmersburg WWTP	IN0021148	Busseron Creek (W FK) to Wabash River
Black Beauty Coal Farmersburg	ING040062	Busseron, Spunge and Turman Creeks
Atkinson Excavating Caledon	ING040195	Busseron Creek
AML Site 931, Rust Construction	ING040200	Mud Creek via Unnamed Tributary
AML Site 319, Rust Construction	ING040203	Busseron Creek via Buttermilk Creek
Farmersburg Bear Run	ING040128	Buttermilk, Middle Fork and Unnamed Tributary
Farmersburg Mine Bear Run	ING040127	Kettle, Mud, Busseron, and Buttermilk Creeks
Heartland Gas Pipeline	ING670044	Located in Sulpher Creek Subwatershed
Coal Field Development, Hymera Mine	ING040198	Located in Sulpher Creek Subwatershed
Sunrise Coal	IN0062791	Busseron Creek
Jericho, Sullivan County CBM Field	IN0062758	Buttermilk Creek, Busseron Creek

Table 8. Summary of Permit Violations for the NPDES Facilities in the Busseron Creek Watershed for the Five Year Period Ending October 2007.

Facility	Violations
Allomatic Products	2 pH violations
Dugger WWTP	19 dissolved oxygen violations and 11 TSS violations
Farmersburg Mine Bear Run	14 pH violations and 3 TSS violations (multiple outfalls)
Farmersburg Mine Bear Run (East Pit)	6 iron violations (multiple outfalls)
Farmersburg WWTP	10 dissolved oxygen violations; 1 pH violation; 87 TSS violations
Hymera Municipal WWTP	9 dissolved oxygen violations; 2 pH violations; 55 TSS violations
Shakamak State Park WWTP	8 dissolved oxygen violations; 1 pH violation; 15 TSS violations
Shelburn WWTP	2 dissolved oxygen violations; 3 total phosphorus violations; 14 TSS violations
Sullivan Municipal WWTP	6 pH violations; 1 TSS violation

4.1.2 Concentrated Animal Feeding Operations

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations falls under the regulations for concentrated animal feeding operations (CAFOs). The animals raised in confined feeding operations produce manure that is stored in pits, lagoons, tanks and other storage devices. Confined feeding operations can pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication can adversely impact soil productivity.

Although there are four active confined feeding operations in Busseron Creek watershed, none are large enough to be classified as CAFOs.

4.1.3 Combined Sewer Systems

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater into the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows (CSOs), can contain both storm water and untreated human and industrial waste. Because they are associated with wet weather events, CSOs typically discharge for short periods of time at random intervals.

The Sullivan Municipal WWTP operates the only combined sewer system in the watershed (Figure 5). There are two active CSOs (numbers 002 and 003) and they are located along Buck Creek on the west side of the city.

4.1.4 Storm Water Phase II Communities

Under Phase II of the NPDES storm water program, rules have been developed to regulate most Municipal Separate Storm Sewer Systems (MS4s). Operators of Phase II-designated small MS4s are required to apply for NPDES permit coverage and to implement storm water discharge management controls (known as “best management practices” (BMPs)). There are no MS4s within the Busseron Creek watershed.

4.1.5 Illicitly Connected “Straight Pipe” Systems

Some household wastes within Indiana and potentially within the Busseron Creek watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants to the stream (these systems are sometimes referred to as “straight pipe” discharges). These systems are technically classified as point sources; however, since they are illegal they receive a wasteload allocation of zero.

4.2 Nonpoint Sources

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or faulty septic systems, runoff from lawn fertilizer applications, pet waste, storm water runoff (outside of MS4 communities), and other sources. In more rural areas, major contributors can be runoff from agricultural lands and abandoned mine lands.

4.2.1 Agriculture

Approximately 45 percent of the land in the Busseron Creek watershed is classified as row crops and another 20 percent is classified as pasture and grasslands. These lands can be a source of both sediments and nutrients. Accumulation of nutrients on cropland occurs from decomposition of residual crop material, fertilization with chemical (e.g., anyhdrous ammonia) and manure fertilizers, atmospheric deposition, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. The majority of nutrient loading from cropland occurs from fertilization with commercial and manure fertilizers (USEPA, 2003). Use of manure for nitrogen supplementation often results in excessive phosphorus loads relative to crop requirements (USEPA, 2003).

Runoff from pastures and livestock operations can also be potential agricultural sources of nutrients. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event. The following five active confined feeding operations exist in the Busseron Creek watershed:

- Bowen Turkey Farm (ID 4939)
- Dear Creek Farm (ID 6008)
- Triple C Farms (ID 6029)
- Long Acre Farms (ID 6142)
- Willis (ID 3994)

4.2.2 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations in Indiana which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters (Horsely and Witten, 1996).

There are a significant number of old houses in the Busseron Creek watershed that either have septic systems that do not function properly or have not been updated to the current standards. Illegal dumping of sewage as well as septic failures are also a common phenomenon in the watershed (Cundiff, 2007), although no information on the specific number of failing systems is available. Failing septic systems are sources of nutrients that can reach nearby streams through both runoff and groundwater flows.

4.2.3 Abandoned Surface and Underground Mining

A majority of the Busseron Creek watershed is covered by abandoned surface and underground mining sites (Figure 5). The Surface Mining Control and Reclamation Act of 1977 addresses the water-quality problems associated with acid mine drainage. This act requires that extensive information about the probable hydrologic consequences of mining and reclamation be included in mining-permit application so that the regulatory authority can determine the probable cumulative impact of mining on the hydrology.

The Busseron Creek watershed was extensively coal mined (surface and underground) from the late 1800's until the mid-1900's (REFERENCE). Historic, pre-law practices have had a significant influence on the streams and surrounding landscape of the watershed. Several of these impacts include:

- Residual strip mine ponds and mine waste piles (gob piles)
- Surface hydrology alteration
- Complete elimination of some headwater streams
- Altered topography and vegetation
- Increased stream bank erosion and sedimentation

Additional coal mining impacts include mine collapses/blowouts and subsidences. In some cases, abandoned underground mines may cave in (also known as a subsidence) and "capture" the stream flowing over it. Once normally flowing streams dry up as their flow is re-routed underground into a series of old shafts and mining rooms. As the water mixes with oxygen and comes into contact with pyrite in the residual coal seams, sulfuric acid is formed. The highly acidic water eventually percolates to the surface elsewhere in the watershed through rock fractures, old auger holes, or mine shafts and has the ability to significantly influence water quality.

The residual effects of pre-law mining have scarred the terrestrial landscape of the watershed, and these impacts have had a significant influence on water quality as AMD from seeps, mine tailings/gob piles, and exposed coal seems enters Busseron Creek and its tributaries. AMD generally displays elevated levels of one or more of the following parameters (Bauers et al, 2006):

- Acidity
- Metals
- Sulfates
- Suspended Solids

5.0 TECHNICAL APPROACH

This section represents the technical approach used to estimate the current and allowable loads of the pollutants of concern in the Busseron Creek watershed. Load reductions were determined through the use of load duration curves. The load duration curve calculates the allowable loadings of a pollutant at different flow regimes by multiplying each flow by the TMDL target value and an appropriate conversion factor. The following steps are taken:

1) A flow duration curve for the stream is developed by generating a flow frequency table and plotting the observed flows in order from highest (left portion of curve) to lowest (right portion of curve).

2) The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the TMDL target value and by a conversion factor and the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., mg/L) to loads (e.g., kg/day) with the following factors used for this TMDL:

   a) Flow (cfs) x TMDL Concentration Target (mg/L) x Conversion Factor (2.45) = Load (kg/day)
   b) Flow (cfs) x TMDL Concentration Target (μg/L) x Conversion Factor (0.00245) = Load (kg/day)

3) To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.

4) Points plotting above the curve represent deviations from the water quality standard and the daily allowable load. Those points plotting below the curve represent compliance with standards and the daily allowable load.

5) The area beneath the TMDL curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards.

The stream flows displayed on a load duration curve may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into 10 groups, which can be further categorized into the following five “hydrologic zones” (Cleland, 2005):

- High flow zone: stream flows that plot in the 0 to 10-percentile range, related to flood flows.
- Moist zone: flows in the 10 to 40-percentile range, related to wet weather conditions.
- Mid-range zone: flows in the 40 to 50 percentile range, median stream flow conditions;
- Dry zone: flows in the 60 to 90-percentile range, related to dry weather flows.
- Low flow zone: flows in the 90 to 100-percentile range, related to drought conditions.

The load duration approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Table 11summarizes the relationship between the five hydrologic zones and potentially contributing source areas.

The load reduction approach also considers critical conditions and seasonal variation in the TMDL development as required by the Clean Water Act and EPA’s implementing regulations. Because the approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

Table 9. Relationship Between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
On-site wastewater systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Stormwater: Impervious		H	H	H	
Combined sewer overflow (CSO)	H	H	H		
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			
Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)					

5.1 Stream Flow Estimates

Daily estimates of stream flows are necessary to implement the load duration curve approach. These were estimated using the observed flows available at the USGS gage on Busseron Creek (gage ID 03342500) and a drainage area ratio. In this procedure, the drainage area of each of the load duration stations was divided by the drainage area (228 square miles) of gage 03342500. The flows, for each of the stations were then calculated by multiplying the 03342500 flows by the drainage area ratios.

Gage 03342500 was inactive between December 2, 2003 and May 2, 2007, a period which includes the majority of the available water chemistry samples for the Busseron Creek watershed. Flows during this period were therefore estimated based on flows from the nearby Mill Creek watershed as outlined in Appendix G.

6.0 ALLOCATIONS

This section of the report presents the various components of the TMDL, as required by the Clean Water Act.

6.1 Results by Impaired Segment

A TMDL must identify the loading capacity of a waterbody for the applicable pollutant and EPA regulations define loading capacity as the “greatest amount of a pollutant that a water can receive without violating water quality standards.” The loading capacity is often also referred to as the “allowable” load. The following sections provide the results of the load duration curve analysis for aluminum, copper, iron, manganese, phosphorus, total suspended solids (TSS), and zinc. More details of the analysis are shown in Appendix E.

It should be noted that Busseron Creek segments INB11G8_T1036 (station 15) and INB11GB_T1037 (stations 21 and 22) are listed as impaired due to poor biotic communities even though no pollutants were found to exceed the TMDL targets. Improved water quality conditions resulting from the TMDLs developed for upstream locations are expected to eventually result in full support of the aquatic life use at segments INB11G8_T1036 and INB11GB_T1037.

6.1.1 Sulpher Creek Station 1 (Segment INB11G4_T1024)

Sulpher Creek at Station 1 is impaired due to aluminum, iron, phosphorus, pH and zinc (Table 10). Historical data indicated that copper also exceeded water quality standards; however, as recent data do not suggest a copper impairment, no copper TMDL was developed.

Table 10. Statistical Summary of TMDL parameters at Stream Segment INB11G4_T1024 (Station 1)

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	9	9	100%	977	14600	9509.70
Iron (µg/L)	9	8	88%	2330	32400	7400.00
Phosphorus (mg/L)	9	2	20%	0.031	0.503	0.15
Zinc (µg/L)	9	8	88%	45.5	1430	953.17

As explained in Section 3.1, both acute and chronic water quality standards exist for zinc. The loading capacity is calculated using the chronic criterion because it is more restrictive and ensures that both standards will be met. The zinc water quality standard also varies based on hardness. Appendix C displays the hardness for each sampling event and the corresponding water quality standards are presented in Appendix D. Among the ten CAC values computed for Station 1, the lowest zinc criterion was 239 µg/L and was used to develop the zinc TMDL.

The TMDL for Sulpher Creek Station 1 is summarized in Table 11. The only point source located upstream of Station 1 (Heartland Gas Pipeline: ING670044) is inactive and is also not considered a significant source of any of the pollutants of concern. The WLA is therefore set to zero. Underground and surface mines are prevalent throughout the watershed and are considered the primary sources of the metals. Private sewage systems and agricultural activities are potential sources of phosphorus.

Sulpher Creek at Station 1 is also impaired for pH, which is caused by seeps from abandoned mine lands. The water quality criteria for pH requires it to be above 6 and below 9. In the case of acid mine drainage, pH can be a misleading characteristic. Water with near neutral pH (~7) but containing elevated concentrations of dissolved ferrous (Fe2+) ions can become acidic after oxidation and precipitation of the iron. Therefore, a more practical approach to meeting the water standards of pH is to use the concentration of metal ions as a surrogate for pH. Through reducing instream metals, namely aluminum and iron, to meet water quality criteria (or TMDL endpoints), it is assumed that the pH will result in meeting the water quality standards.

Table 11. TMDL Summary for Sulpher Creek Station 1 (Segment INB11G4_T1024).

Sulpher Creek Station 1 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	0	133.67	26.31	23.68	0	2.63
	Moist Conditions	0	69.74	5.9	5.31	0	0.59
	Mid-Range Flows	0	41.84	2.21	1.99	0	0.22
	Dry Conditions	0	Unknown	0.8	0.72	0	0.08
	Low Flows	0	Unknown	0.16	0.14	0	0.02
Iron (kg/day)	**High Flows**	0	178.93	87.71	78.94	0	8.77
	Moist Conditions	0	95.95	21.69	19.52	0	2.17
	Mid-Range Flows	0	11.99	7.36	6.63	0	0.74
	Dry Conditions	0	Unknown	2.66	2.39	0	0.27
	Low Flows	0	Unknown	0.54	0.49	0	0.05
Phosphorus (kg/day)	**High Flows**	0	13.96	10.53	9.48	0	1.05
	Moist Conditions	0	5.66	3.38	3.04	0	0.34
	Mid-Range Flows	0	0.12	0.88	0.79	0	0.09
	Dry Conditions	0	Unknown	0.32	0.29	0	0.03
	Low Flows	0	Unknown	0.07	0.06	0	0.01
Zinc (kg/day)	**High Flows**	0	1.6	8.38	7.55	0	0.84
	Moist Conditions	0	7.59	1.88	1.69	0	0.19
	Mid-Range Flows	0	4.17	0.70	0.63	0	0.07
	Dry Conditions	0	Unknown	0.26	0.23	0	0.03
	Low Flows	0	Unknown	0.06	0.05	0	0.01

6.1.2 Sulpher Creek Station 2 (Segment INB11G4_ T1024)

Sulpher Creek at Station 2 is impaired for aluminum, iron, phosphorus, pH, TSS, and zinc (0) and the TMDL for Sulpher Creek Station 2 is summarized in Table 13. The lowest calculated zinc criterion for Station 2 (178 µg/L) was used to develop the loading capacity. The only point source located upstream of Station 2 is the Heartland Gas Pipeline (ING670044) and so the WLA is set to zero. Underground and surface mines are prevalent throughout the watershed and are considered the primary sources of the metals and TSS. Private sewage systems and agricultural activities are potential sources of phosphorus and TSS.

Table 12. Statistical Summary of TMDL parameters at Stream Segment INB11G4_T1024 (Station 2)

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	9	9	100%	804	13500	6856.73
Iron (µg/L)	9	6	66%	943	35900	8106.64
Phosphorus (mg/L)	9	4	44%	0.068	1.16	0.35
TSS (mg/L)	1	1	100%	150	150	150
Zinc (µg/L)	9	7	77%	39	1070	593.11

Table 13. TMDL Summary for Sulpher Creek Station 2 (Segment INB11G4_T1024).

Sulpher Creek Station 2 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	0	170.44	34.41	30.97	0	3.44
	Moist Conditions	0	59.19	7.51	6.76	0	0.75
	Mid-Range Flows	0	26.92	2.89	2.60	0	0.29
	Dry Conditions	0	Unknown	1.05	0.94	0	0.10
	Low Flows	0	Unknown	0.21	0.19	0	0.02
Iron (kg/day)	**High Flows**	0	211.50	114.70	103.23	0	11.47
	Moist Conditions	0	149.23	28.54	25.68	0	2.85
	Mid-Range Flows	0	4.24	9.63	8.67	0	0.96
	Dry Conditions	0	Unknown	3.48	3.14	0	0.35
	Low Flows	0	Unknown	0.71	0.64	0	0.07
Phosphorus (kg/day)	**High Flows**	0	20.94	13.76	12.39	0	1.38
	Moist Conditions	0	8.74	3.39	3.05	0	0.34
	Mid-Range Flows	0	0.64	1.16	1.04	0	0.12
	Dry Conditions	0	Unknown	0.42	0.38	0	0.04
	Low Flows	0	Unknown	0.09	0.08	0	0.01
TSS (kg/day)	**High Flows**	0	Unknown	7,661	6,895	0	766
	Moist Conditions	0	Unknown	836	752	0	84
	Mid-Range Flows	0	Unknown	160	144	0	16
	Dry Conditions	0	Unknown	70	63	0	7
	Low Flows	41	41	8	7	0	1
Zinc (kg/day)	**High Flows**	0	2.05	8.15	7.33	0	0.81
	Moist Conditions	0	8.25	1.91	1.72	0	0.19
	Mid-Range Flows	0	4.03	0.68	0.62	0	0.07
	Dry Conditions	0	Unknown	0.25	0.22	0	0.02

Sulpher Creek Station 2 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	Flow Regime	Point Sources	Nonpoint Sources	TMDL= LA+WLA+ MOS	LA	WLA: Total	MOS (10%)
	Low Flows	0	Unknown	0.05	0.05	0	0.01

6.1.3 Sulpher Creek Station 3 (Segment INB11G4_ T1024)

Sulpher Creek at Station 3 is impaired by aluminum, copper, iron, manganese, and phosphorus (Table 14). Loading capacities were calculated by applying chronic standards of 11.4 µg/L for copper**,** 513.39 µg/L for manganese, and 102.23 µg/L for zinc and the TMDL is summarized in Table 15.

Table 14. Statistical Summary of TMDL parameters at Stream Segment INB11G4_T1024 (Station 3).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	9	7	77%	136	19700	5103.82
Copper (µg/L)	9	1	11%	2.22	43.4	11.77
Iron (µg/L)	9	3	33%	476	23600	6831.73
Manganese (µg/L)	9	7	77%	374	1560	966.55
Phosphorus (mg/L	9	2	22%	0.029	1.04	0.40
Zinc (µg/L)	9	5	55%	60.9	632	370.72

The following two NPDES facilities are located upstream of Station 3:

- Heartland Gas Pipeline (ING670044)
- Hymera Municipal WWTP (IN0040134)
- Coal Field Development, Hymera Mine (ING040198)

Hymera Municipal WWTP may not be a major source of metals, but is a potential source of phosphorus. The phosphorus WLA allocation was therefore computed by multiplying the design flow (0.125 MGD) with the TMDL standard of 0.3 mg/L.

The Coal Field Development mine is a potential source of aluminum, copper, iron, manganese and zinc. However, the facility only has a general permits and therefore no design flow is available. The facility is also not considered to be a significant source of the existing loadings based on many other tributaries in the watershed being impaired. The WLA is therefore set equal to the existing permit limit for iron (3 mg/L daily average; 6 mg/L daily maximum) and the existing load for aluminum.

Table 15. TMDL Summary for Sulpher Creek Station 3 (Segment INB11G4_T1024).

Sulpher Creek Station 3 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	Unknown	1,594.98	60.72	54.65	The WLA is set equal to the current load	6.07
	Moist Conditions	Unknown	29.84	13.25	11.92		1.32
	Mid-Range Flows	Unknown	1.75	5.09	4.58		0.51
	Dry Conditions	Unknown	Unknown	1.84	1.66		0.18
	Low Flows	Unknown	Unknown	0.38	0.34		0.04
Copper (kg/day)	**High Flows**	Unknown	3.51	0.92	0.83	The WLA is set equal to the current load	0.09
	Moist Conditions	Unknown	0.07	0.17	0.15		0.02
	Mid-Range Flows	Unknown	0.02	0.08	0.07		0.01
	Dry Conditions	Unknown	Unknown	0.03	0.03		0
	Low Flows	Unknown	Unknown	0.01	0.01		0
Iron (kg/day)	**High Flows**	Unknown	1, 910.74	202.41	182.17	The WL A is set equal to the existing general permit limit (6 mg/L daily maximum)	20.24
	Moist Conditions	Unknown	55.22	51.70	46.53		5.17
	Mid-Range Flows	Unknown	4.58	16.96	15.26		1.70
	Dry Conditions	Unknown	Unknown	6.15	5.53		0.61
	Low Flows	Unknown	Unknown	1.26	1.13		0.13
Manganese (kg/day)	**High Flows**	Unknown	126.30	32.34	29.10	The WL A is set equal to the existing general permit limit (4 mg/L daily maximum)	3.23
	Moist Conditions	Unknown	15.44	8.35	7.52		0.84
	Mid-Range Flows	Unknown	9.10	2.71	2.44		0.27
	Dry Conditions	Unknown	Unknown	0.98	0.88		0.10
	Low Flows	Unknown	Unknown	0.20	0.18		0.02
Phosphorus (kg/day)	**High Flows**	Unknown	38.54	24.29	21.72	0.14	2.43
	Moist Conditions	Unknown	25.88	7.80	6.88	0.14	0.78
	Mid-Range Flows	Unknown	0.21	2.03	1.68	0.14	0.20
	Dry Conditions	Unknown	Unknown	0.74	0.52	0.14	0.07
	Low Flows	Unknown	Unknown	0.15	0.0	0.14	0.01
Zinc (kg/day)	**High Flows**	Unknown	15.63	8.28	7.45	The WLA is set equal to the current load	0.83
	Moist Conditions	Unknown	9.67	1.88	1.69		0.19
	Mid-Range Flows	Unknown	3.13	0.69	0.62		0.07

Sulpher Creek Station 3 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
	Dry Conditions	Unknown	Unknown	0.25	0.23		0.03
	Low Flows	Unknown	Unknown	0.05	0.05		0.01

6.1.4 Sulpher Creek Station 4 (Stream Segment INB11G4_ T1024)

Aluminum is the only parameter of concern at station 4 with three of the ten collected samples exceeding the target value (Table 16).

Table 16. Statistical Summary of TMDL parameters at Stream Segment INB11G4_T1024 (Station 4).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	8	2	25%	195	1800	683.900

The upstream Coal Field Development Mine is a potential source of aluminum and the WLA is set equal to the current load from this facility. The TMDL summary is presented in Table 17.

Table 17. TMDL Summary for Sulpher Creek Station 4 (Segment INB11G4_T1024).

Sulpher Creek Station 4 (Segment INB11G4_T1024)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	Unknown	74.76	109.30	98.37	The WLA is set equal to the current load.	10.93
	Moist Conditions	Unknown	10.64	23.59	21.23		2.36
	Mid-Range Flows	Unknown	14.67	9.18	8.26		0.92
	Dry Conditions	Unknown	Unknown	3.32	2.99		0.33
	Low Flows	Unknown	Unknown	0.68	0.61		0.07

6.1.5 Busseron Creek Station 5 (Stream Segment INB11G4_ 00)

Station 5 is impaired due to aluminum and iron (Table 18).

Table 18. Statistical Summary of TMDL parameters at Stream Segment INB11G4_00 (Station 5).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	1	1	100%	4010	4010	4010
Iron (µg/L)	1	1	100%	3310	3310	3310

Among the following five NPDES facilities upstream of station 3, the Black Beauty Coal and Coal Field Development mines are potential sources of aluminum and iron. However, these are general permits and therefore no design flows are available. The permittees are also not considered to be significant sources of the existing loadings as many other tributaries in the watershed are also impaired due to aluminum and iron. The WLA is therefore set equal to the existing permit limit for iron (3 mg/L daily average; 6 mg/L daily maximum) and current loads for aluminum.

- Heartland Gas Pipeline (ING670044)
- Hymera Municipal WWTP (IN0040134)
- Black Beauty Coal Farmersburg (ING040062)
- Farmersburg WWTP (IN0021148)
- Coal Field Development Mine (ING040198)

The WLAs for the two treatment plants are set to zero because they are not considered sources of aluminum or iron. Table 19 summarizes the TMDL. There limited data with which to estimate existing loads.

Table 19. TMDL Summary for Busseron Creek Station 5 (Segment INB11G4_00).

Busseron Creek Station 5 (Segment INB11G4_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	0	Unknown	2,614	2,352	The WLA is set equal to the current load.	261
	Moist Conditions	0	461	86	78		9
	Mid-Range Flows	0	Unknown	54	49		5
	Dry Conditions	0	Unknown	24	21		2
	Low Flows	0	Unknown	5	4		0
Iron (kg/day)	**High Flows**	0	Unknown	8,713	7,841	The WLA is set equal to the existing general permit limits (3 mg/L daily average; 6 mg/L daily maximum)	871
	Moist Conditions	0	379	287	259		29
	Mid-Range Flows	0	Unknown	182	163		18
	Dry Conditions	0	Unknown	79	72		8
	Low Flows	0	Unknown	16	14		2

6.1.6 Mud Creek Station 9 (Stream Segment INB11G6_ 00)

Mud Creek at Station 9 is impaired due to aluminum, iron, and pH (Table 20). The Indiana Department of Natural Resources (DNR) also samples at this location (station 931A) and the DNR data were therefore incorporated into the analysis.

Table 20. Statistical Summary of TMDL parameters at Stream Segment INB11G6_00 (Station 9.)

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	13	2	15%	26.9	4790	1392.66
Iron (µg/L)	20	3	15%	448	4370	1122.06

The TMDL results are shown in Table 21. There are no point sources located upstream of this station and historic mining areas are believed to be the primary source of aluminum and iron. As discussed in Section 6.1.1, aluminum and iron load reductions are expected to achieve the desired pH level in Mud Creek.

Table 21. TMDL Summary for Mud Creek Station 9 (Segment INB11G6_00).

Mud Creek Station 9 (Segment INB11G6_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	No Point Sources	25.31	16.25	14.63	No Point Sources	1.63
	Moist Conditions		0.59	2.22	2.00		0.22
	Mid-Range Flows		0.04	1.01	0.91		0.10
	Dry Conditions		Unknown		0.33		0.04
	Low Flows		Unknown	0.08	0.07		0.01
Iron (kg/day)	**High Flows**		16.08	39	35.10		3.90
	Moist Conditions		16.28	9.40	8.46		0.94
	Mid-Range Flows		3.26	3.24	2.91		0.32
	Dry Conditions		Unknown	1.23	1.11		0.12
	Low Flows		Unknown	0.25	0.23		0.03

6.1.7 Mud Creek Station 10 (Stream Segment INB11G6_ 00)

Mud Creek Station 10 is impaired due to aluminum, dissolved oxygen, iron, and TSS (Table 22). DNR data are also available for this location and were included in the analysis.

Table 22. Statistical Summary of TMDL parameters at Stream Segment INB11G6_00 (Station 10).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	17	11	64%	56.2	36800	4173.83
Iron (µg/L)	20	19	95%	1730	69800	19403.50
TSS (mg/L)	13	7	53%	4	61	36.9083

The TMDL is summarized in Table 23. AML Site 931 (INGO40200) is the only NPDES facility upstream of station 10. Since it is inactive, the WLA is set to zero. Historic mining areas are believed to be the primary source of aluminum, iron, and TSS.

The specific cause of the low dissolved oxygen at Mud Creek Station 10 is not known with certainty but is suspected to be related to the abandoned mine issues. For example, studies have shown that the oxidation of iron can consume a significant volume of dissolved oxygen (USGS, 1986). IDEM believes that addressing the iron impairment will therefore result in attaining the water quality standards for dissolved oxygen.

Table 23. TMDL Summary for Mud Creek Station 10 (Segment INB11G6_00).

Mud Creek Station 10 (Segment INB11G6_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	Flow Regime	Point Sources	Nonpoint Sources	TMDL= LA+WLA+ MOS	LA	WLA: Total	MOS (10%)
Aluminum (kg/day)	High Flows	0	219.92	76.04	68.44	0	7.60
	Moist Conditions	0	47.77	14.58	13.12	0	1.46
	Mid-Range Flows	0	163.92	7.46	6.72	0	0.75
	Dry Conditions	0	Unknown	2.40	2.16	0	0.24
	Low Flows	0	Unknown	0.49	0.44	0	0.05
Iron (kg/day)	High Flows	0	733.39	253.47	228.13	0	25.35
	Moist Conditions	0	409.64	51.11	46	0	5.11
	Mid-Range Flows	0	225.31	23.76	21.38	0	2.38
	Dry Conditions	0	Unknown	7.99	7.19	0	0.80
	Low Flows	0	Unknown	1.63	1.47	0	0/16
TSS (kg/day)	High Flows	0	3,803.52	2,925.78	2,633.20	0	292.58
	Moist Condition	0	1,041.61	599.57	539.61	0	59.96
	Mid-Range Flows	0	425	344.60	310.14	0	34.46
	Dry Conditions	0	Unknown	95.90	86.31	0	9.59
	Low Flows	0	3.67	18.33	16.49	0	1.83

6.1.8 Mud Creek Station 11 (Stream Segment INB11G6_ 00).

Mud Creek at Station 11 is impaired due to aluminum and iron (Table 24).

Table 24. Statistical Summary of TMDL parameters at Stream Segment INB11G6_00 (Station 11).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	8	4	50%	32.2	10300	2696.87
Iron (µg/L)	8	5	62%	116	29300	7131.22

The TMDL is summarized in Table 25. AML Site 931 (INGO40200) is the only NPDES facility upstream of station 10. Since it is inactive, the WLA is set to zero. Historic mining areas are believed to be the primary source of aluminum, iron, and TSS.

Table 25. TMDL Summary for Mud Creek Station 11 (Segment INB11G6_00).

Mud Creek Station 11 (Segment INB11G6_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	0	347.17	97.16	87.44	0	9.72
	Moist Conditions	0	38.76	15.80	14.22	0	1.58
	Mid-Range Flows	0	0.35	8.11	7.30	0	0.81
	Dry Conditions	0	Unknown	2.95	2.66	0	0.30
	Low Flows	0	Unknown	0.60	0.54	0	0.06
Iron (kg/day)	**High Flows**	0	558.32	323.85	291.47	0	32.39
	Moist Conditions	0	471.16	72.24	65.01	0	7.22
	Mid-Range Flows	0	1.33	27.19	24.47	0	2.72
	Dry Conditions	0	Unknown	9.84	8.85	0	0.98
	Low Flows	0	Unknown	2.01	1.81	0	0.20

6.1.9 Big Branch Station 12 (Stream Segment INB11G6_ 00)

Big Branch Station 12 was identified as impaired due to aluminum and iron based on limited sampling data available from DNR (Table 26). A tributary to Big Branch (segment INB11G5_00) was also identified as impaired due to aluminum and biotic communities. Additional data should be collected at this station to better characterize current loadings.

Table 26. Statistical Summary of TMDL parameters at Stream Segment INB11G6_00 (Station 12).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	2	1	50%	213	868	540
Iron (µg/L)	2	2	100%	3590	5500	4550

The following four NPDES facilities are located upstream of this station:

- Shakamak State Park (IN0030228)
- Latta Indiana Diesel (IN0002119)
- AML Site 931 (ING040200)
- Farmersburg Mine Bear Run (ING040127)

The Farmersburg Mine Bear Run is a potential source of aluminum and iron and the WLA is set equal to the general permit limits. The remaining facilities are not sources of aluminum or iron and the WLAs are set to zero. The TMDL is summarized in Table 27

Table 27. TMDL Summary for Big Branch Creek Station 12 (Segments INB11G6_00 and INB11G5_00).

Big Branch Station 12 (Segment INB11G6_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	Unknown	Unknown	1,701	1,531	The WLA is set equal to the current load	170
	Moist Conditions	Unknown	86	74	67		7
	Mid-Range Flows	Unknown	8	28	25		3
	Dry Conditions	Unknown	Unknown	16	14		2
	Low Flows	Unknown	Unknown	3	3		0
Iron (kg/day)	**High Flows**	Unknown	Unknown	5,671	5,104	The WLA is set equal to the existing general permit limits (3 mg/L daily average; 6 mg/L daily maximum)	567
	Moist Conditions	Unknown	354	246	222		25
	Mid-Range Flows	Unknown	207	94	85		9
	Dry Conditions	Unknown	Unknown	52	47		5
	Low Flows	Unknown	Unknown	10	9		1

6.1.10 Kettle Creek Station 13 (Stream Segment INB11G7_ T1035)

Kettle Creek at Station 13 is impaired due to phosphorus and is potentially impaired due to TSS (Table 28); the TMDL is summarized in Table 29. There are no NPDES permittees upstream of this station and the primary sources of phosphorus and TSS are believed to be agricultural activities, failing septic systems, and land disturbance associated with historic mining activities.

Table 28. Statistical Summary of TMDL parameters at Stream Segment INB11G7_T1035 (Station 13).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Phosphorus (mg/L)	9	4	44%	0.134	1.76	0.447
TSS (mg/L)	1	1	100%	296	296	296

Table 29. TMDL Summary for Kettle Creek Station 13 (Segment INB11G7_00).

Kettle Creek Station 13 (Segment INB11G7_T1035)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Phosphorus (kg/day)	High Flows	No Point Sources	60.77	43.72	39.35	No Point Sources	4.37
	Moist Conditions		9.61	8.03	7.22		0.80
	Mid-Range Flows		14.52	3.67	3.30		0.37
	Dry Conditions		Unknown	1.33	1.20		0.13
	Low Flows		Unknown	0.27	0.24		0.03
TSS (kg/day)	High Flows		Unknown	24,336	21,902		2,434
	Moist Conditions		Unknown	2,656	2,390		266
	Mid-Range Flows		Unknown	507	457		51
	Dry Conditions		Unknown	222	200		22
	Low Flows		250	25	23		3

6.1.11 Buttermilk Creek Station 16 (Stream Segment INB11G9_ 00).

Based on the available DNR data, Buttermilk Creek at Station 16 is impaired by aluminum and TSS (Table 30) and the TMDL is summarized in Table 31.

Table 30. Statistical Summary of TMDL parameters at Stream Segment INB11G9_00 (Station 16).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	8	1	12%	180	1020	490.50
TSS (mg/L)	12	2	16%	6	60	19.55

There are three NPDES facilities upstream of this station:

- Farmersburg Bear Run (ING040128)
- Dugger Municipal STP
- Jericho, LLC-Sullivan County CBM Field (IN0062758)

The Farmersburg Bear Run is inactive and is not a manor contributor of aluminum and TSS. The Jericho CBM Field is also not a potential source of aluminum. The Dugger Municipal STP has a weekly average TSS limit of 19 mg/L during the summer and 25 mg/L during the winter. These limits were multiplied by the design flow of 0.125 MGD to calculate the WLAs.

Table 31. TMDL Summary for Buttermilk Creek Station 16 (Segment INB11G9_00).

Buttermilk Creek Station 16 (Segment INB11G9_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	Flow Regime	Point Sources	Nonpoint Sources	TMDL= LA+WLA+ MOS	LA	WLA: Total	MOS (10%)
Aluminum (kg/day)	High Flows	0	33.63	43.49	39.14	0	4.35
	Moist Conditions	0	8.04	6.78	6.10	0	0.68
	Mid-Range Flows	0	7.39	5.44	4.89	0	0.54
	Dry Conditions	0	918.81	1.77	1.59	0	0.18
	Low Flows	0	Unknown	0.64	0.58	0	0.06
TSS (kg/day)	High Flows	12	918.81	1,739.64	1,553.68	12	173.96
	Moist Conditions	12	533.21	271.11	232.00	12	27.11
	Mid-Range Flows	12	324.35	217.40	183.66	12	21.74
	Dry Conditions	9	Unknown	70.73	54.66	9	7.07
	Low Flows	9	5.03	25.16	13.64	9	2.52

6.1.12 Buttermilk Creek Station 17 (Stream Segment INB11G9_ 00)

Based on the available DNR data, Buttermilk Creek at Station 17 is impaired by aluminum, iron, and TSS (Table 32) and the TMDL is summarized in Table 33.

Table 32. Statistical Summary of TMDL parameters at Stream Segment INB11G9_00 (Station 17).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Aluminum (µg/L)	10	4	40%	168	2680	705.70
Iron (µg/L)	12	9	75%	152	11800	5408.50
TSS (mg/L)	12	2	16%	9	41	22.83

Among the three NPDES facilities located upstream of Station 17 (and listed below), the Dugger Municipal STP and Jericho CBM Field are the only active facilities. TSS WLAs were established consistent with existing permit limits for the Dugger Municipal STP. The Jericho CBM Field is potential source of iron and the WLA was set equal to the existing general permit limits.

- Farmersburg Bear Run (ING040128)
- Dugger Municipal STP
- AML Site 319 (ING040203)
- Jericho, LLC-Sullivan County CBM Field (IN0062758)

Table 33. TMDL Summary for Buttermilk Creek Station 17 (Segment INB11G9_00).

Buttermilk Creek 17 (Segment INB11G9_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Aluminum (kg/day)	**High Flows**	0	138.40	133.16	119.84	0	13.32
	Moist Conditions	0	46.62	25.66	23.09	0	2.57
	Mid-Range Flows	0	4.50	15.68	14.12	0	1.57
	Dry Conditions	0	Unknown	4.36	3.93	0	0.44
	Low Flows	0	Unknown	0.89	0.80	0	0.99
Iron (kg/day)	**High Flows**	Unknown	433.22	443.87	399.48	The WLA is set equal to the existing general permit limits (3 mg/L daily average; 6 mg/L daily maximum)	44.39
	Moist Conditions	Unknown	222.86	86.82	78.13		8.68
	Mid-Range Flows	Unknown	180.61	47.13	42.42		4.71
	Dry Conditions	Unknown	Unknown	14.55	13.09		1.45
	Low Flows	Unknown	Unknown	2.98	2.68		0.30
TSS (kg/day)	**High Flows**	12	3897.04	5,326.42	4,781.78	12	532.64
	Moist Condition	12	1107.89	817.24	723.52	12	81.72
	Mid-Range Flows	12	639.26	627.35	552.62	12	62.73
	Dry Conditions	9	Unknown	174.59	148.13	9	17.46.
	Low Flows	9	Unknown	35.71	23.14	9	3.57

6.1.13 Robbins Creek Station 19 (Stream Segment INB11GA_ 00).

Robbins Creek at Station 19 is impaired due to dissolved oxygen, TSS, and phosphorus (Table 34).

Table 34. Statistical Summary of TMDL parameters at Stream Segment INB11GA_00 (Station 19).

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Phosphorus (mg/L)	9	5	55%	0.175	0.618	0.32
TSS (mg/L)	1	1	100%	114	114	114

The three NPDES facilities located upstream of this station are listed below. Both Allomatic Products and North American Latex Corp are not considered sources of phosphorus and TSS and the WLAs are set to zero. The Sullivan WWTP phosphorus WLA was established based on the design flow (1.12 MGD) multiplied by the TMDL target value of 0.3 mg/L. This facility already has permit limits for TSS (summer 36 mg/L and winter 45 mg/L) and these values were used to set the TSS WLAs.

- Allomatic Products (INP000149)
- North American Latex Corp (INP000161)
- Sullivan WWTP (IN0024554)

The specific cause of the low dissolved oxygen at Station 19 is not known with certainty but is believed to be related to the phosphorus impairment (i.e., excessive phosphorus is causing the excessive growth of algae which, in turn, are consuming too much oxygen during respiration and when they decay). IDEM believes that addressing the phosphorus impairment will therefore result in attaining the water quality standards for dissolved oxygen. The TMDL is summarized in Table 35.

Table 35. TMDL Summary for Robbins Creek Station 19 (Segment INB11GA_00).

Robbins Creek 19 (Segment INB11GA_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	Flow Regime	Point Sources	Nonpoint Sources	TMDL= LA+WLA+ MOS	LA	WLA: Total	MOS (10%)
Phosphorus (kg/day)	High Flows	Unknown	84.34	40.94	35.55	1.30	4.09
	Moist Conditions	Unknown	12.82	11.04	8.64	1.30	1.10
	Mid-Range Flows	Unknown	2.97	4.60	2.84	1.30	0.46
	Dry Conditions	Unknown	Unknown	2.48	0.93	1.30	0.25
	Low Flows	Unknown	Unknown	1.52	0.07	1.30	0.15
TSS (kg/day)	High Flows	191	Unknown	22,209	19,797	191	2,221
	Moist Condition	191	Unknown	2,537	2,092	191	254
	Mid-Range Flows	191	Unknown	587	337	191	59
	Dry Conditions	153	Unknown	328	142	150	33
	Low Flows[1]	Unknown	570	150	0	150	0

[1]The WLA for low flows (153 kg/day) exceeds the calculated loading capacity of 150 kg/day because the WLA is based on a permit limit of 36 mg/L whereas the TMDL target value is 30 mg/L. Therefore the WLA for Dry Conditions and Low Flows was lowered to 150 kg/day and the LA and WLA were set to zero.

6.1.14 Robbins Creek Station 20 (Stream Segment INB11GA_ 00).

Robbins Creek at Station 20 is impaired due to phosphorus (Table 36) and the TMDL is summarized in Table 37. There are no NPDES facilities upstream of this station and sources of phosphorus are believed to include livestock, agricultural activities and septic systems.

Table 36. Statistical Summary of TMDL parameters at Stream Segment INB11GA_00 (Station 20.)

Parameters	Total Number of Samples	Number of Violations	Percent of Samples Violating WQS	Minimum	Maximum	Average
Phosphorus (mg/L)	9	2	22%	0.087	0.581	0.23

Table 37. TMDL Summary for Robbins Creek Station 20 (Segment INB11GA_00).

Robbins Creek 20 (Segment INB11GA_00)		Existing Daily Loads		Total Maximum Daily Load			
Pollutant	**Flow Regime**	**Point Sources**	**Nonpoint Sources**	**TMDL= LA+WLA+ MOS**	**LA**	**WLA: Total**	**MOS (10%)**
Phosphorus(kg/day)	**High Flows**	No Point Sources	17.72	11.33	10.20	No Point Sources	1.13
	Moist Conditions		4.85	3.09	2.78		0.31
	Mid-Range Flows		0.31	0.95	0.86		0.10
	Dry Conditions		Unknown	0.34	0.31		0.03
	Low Flows		Unknown	0.07	0.06		0.01

6.2 Margin of Safety

Section 303(d) of the Clean Water Act and EPA's regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." The margin of safety can either be implicitly incorporated into conservative assumptions used to develop the TMDL or added as a separate explicit component of the TMDL (USEPA, 1991).

A moderate 10 percent explicit MOS was incorporated into all of the Busseron Creek TMDLs. The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. A 10 percent MOS was considered appropriate because the target values used in this study have a firm technical basis and the estimated flows are believed to be relatively accurate.

Implicit margins of safety were also used for the metals TMDLs that have criteria that vary by hardness (copper, manganese, and zinc) because the most stringent criteria were used to calculate all of the loading capacities.

6.3 Allocations

6.3.1 Wasteload Allocations

The WLAs developed for this TMDL are presented in Section 6.1 for each impaired waterbody and are also summarized in Table 38.

Because the phosphorus loads from the Sullivan and Hymera Wastewater Treatment Plants had to be estimated, it is recommended that effluent monitoring for phosphorus be added to these two wastewater treatment plant permits in the next permit renewal cycle. Additional in-stream monitoring should also be performed by IDEM. If the monitoring confirms that the wastewater treatment plant loads are contributing to the impairments, this will need to be addressed by IDEM and the individual facilities after the sampling results are available and interpreted into future permits.

Table 38. WLAs for the Busseron Creek watershed TMDLs.

Facility	Permit Number	WLA
Hymera Municipal WWTP	IN0040134	0.14 kg/day for total phosphorus; zero for all other TMDL parameters.
Sullivan Municipal WWTP	IN0024554	Phosphorus WLA based on the design flow (1.12 MGD) multiplied by the TMDL target value of 0.3 mg/L. TSS WLAs based on existing permit limits for TSS (summer 36 mg/L and winter 45 mg/L)
Allomatic Products	INP000149	Phosphorus and TSS WLAs set to zero
North American Latex Corp	INP000161	Phosphorus and TSS WLAs set to zero
Dugger WWTP	IN0039322	TSS WLA based on existing permit limits of 19 mg/L summer, 25 mg/L winter, and design flow of 0.125 MGD.
Farmersburg WWTP	IN0021148	WLA equals zero for aluminum and iron
Black Beauty Coal Farmersburg	ING040062	The WLA is set equal to the existing permit limit for iron (3 mg/L weekly average; 6 mg/L daily maximum) and aluminum (existing loads with reporting requirement).
AML Site 931, Rust Construction	ING040200	WLA equals zero for all pollutants.
Farmersburg Bear Run	ING040128	WLA equals zero for all pollutants.
Farmersburg Mine Bear Run	ING040127	WLA equals zero for all pollutants.
Heartland Gas Pipeline	ING670044	WLA equals zero for all pollutants.
Jericho, LLC-Sullivan County CBM Field	IN0062758	The WLA is set equal to the existing permit limit for iron (3 mg/L weekly average; 6 mg/L daily maximum) and aluminum (existing loads with reporting requirement).
Coal Field Development Mine	ING040198	The WLA is set equal to the existing permit limit for iron (3 mg/L weekly average; 6 mg/L daily maximum) and aluminum (existing loads with reporting requirement).
Illicitly Connected “Straight Pipe” Systems	None	WLA equals zero for all pollutants.

6.3.2 Load Allocations

The Load Allocations developed for this TMDL are presented in Section 6.1 and vary for each waterbody and pollutant combination. No information is available with which to distinguish the natural sources of the Load Allocations from the anthropogenic sources.

6.4 Critical Conditions and Seasonality

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions for the parameters of concern are needed for specific flow conditions; however, the critical conditions (the periods when the greatest reductions are required) vary by parameter and location (Table 39).

The Clean Water Act also requires that TMDLs be established with consideration of seasonal variations. The load duration approach accounts for seasonality by evaluating allowable loads on a daily basis over the entire range of observed flows and presenting daily allowable loads that vary by flow.

Table 39. Critical Conditions for TMDL Parameters

Parameter	Station	Critical Condition				
		High flows	Moist conditions	Mid Range	Dry Conditions	Low Flows
Aluminum, Total (μg/L)	1			X		
	2			X		
	3	X				
	4			X		
	5		X			
	9	X				
	10		X			
	11	X				
	12		X			
	16			X		
	17		X			
Copper, Total (μg/L)	3	X				
Iron, Total (μg/L)	3	X				
	5		X			
	9		X			
	10			X		
	11		X			
	12			X		
	17			X		
Manganese, Total (μg/L)	3	X				
Phosphorus (mg/L)	1		X			
	2		X			
	3		X			
	13			X		
	19	X				
	20					
Total Suspended Solids (mg/L)	2					X
	10		X			
	13					X
	16		X			
	17		X			
	18					X
	19					X
Zinc, Total (μg/L)	1			X		
	3		X			

7.0 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following public meetings have been held in the watershed to discuss this project:

- A **Kickoff Meeting** was held at the Sullivan County Public Library on March 14, 2007 during which IDEM and Tetra Tech described the TMDL Program and provided a summary of the available data and the proposed modeling approach.

A final meeting will be held in Spring 2008 to present the draft TMDL report. IDEM will also be accepting written comments on the draft report for a period of 30 days.

8.0 IMPLEMENTATION

A variety of controls will need to be implemented to address the sources of impairment in the Busseron Creek watershed. A brief summary of the issues and progress already made for some of the most significant sources is provided below. More specific goals and activities should be identified by persons concerned with improving the health of the watershed. IDEM has Watershed Specialists assigned to different areas of the state and these Watershed Specialists are available to assist stakeholders with starting a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the watershed.

8.1 Abandoned Mine Lands

DNR has a number of watershed projects ongoing throughout the Busseron Creek watershed, primarily to address the issues with abandoned mines. For example, as shown in Table 40 approximately 32,200 tons of lime have been applied to six different sites to neutralize acidic runoff and almost 500 acres of land has been reclaimed by addressing gob piles, slurry spoils, and unvegetated areas (Mark Stacy, DNR, personal communication dated June 15, 2007). Several wetland treatment projects have also been installed to treat acid mine drainage.

Table 40. Summary of DNR mine reclamation projects within the Busseron Creek watershed.

Site	Name	Construction Dates	Amount ($)	Tons of Lime Applied	Total Acres Reclaimed
317	Big Branch	3/9/01 - 4/10/01	254,348.91	1400	22.5
318	Peabody 48	4/7/03 - 8/22/03	76,652.32	200	6.5
319	Vandalia	9/7/04 - 10/12/05	1,441,984.81	2900	102
322	Pandora	10/16/89 - 7/2/90	165,250.93	500	22.5
931	Big Bertha	7/22/04 - 5/24/05	609,051.19	2200	32
287	Friar Tuck	3/30/89 - 5/9/05	1,758,688.49	25,000	295.7

8.2 Agriculture

Nonpoint source pollution from agricultural areas can be reduced by the implementation of best management practices (BMPs). BMPs are practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities. A BMP may be structural, that is, something that is built or involves changes in landforms or equipment, or it may be managerial, that is, changing a specific way of using or handling infrastructure or resources. BMPs should be selected based on the goals of a watershed management plan. Landowners can implement BMPs outside of a watershed management plan, but the success of BMPs is typically enhanced if coordinated as part of a watershed management plan. Following are examples of BMPs that may be appropriate for the Busseron Creek watershed:

8.2.1 Vegetated Filter Strips

Vegetated filter strips are used to reduce the amount of nutrients and sediments that enter a waterbody, reduce erosion around a stream channel, and protect a waterbody from encroachment. Targeted placement of vegetated filter strips can play an important role in reducing pollutants in the watershed.

If vegetated buffers are designed correctly, they can prevent suspended solids, nitrogen, and phosphorus from entering a stream. The ability of the buffer to uptake phosphorus depends on the filter strip design, residence time of the water, and slope of the land. Suspended solids (which can transport phosphorus) are more easily removed by vegetated buffers through settling.

Pennsylvania State University (1992) estimates that the preferred filter strip width for phosphorus will remove 50–75 percent of total phosphorus. Local NRCS personnel and soil and water conservation districts should be consulted to determine the most appropriate design criteria and placement of filter strips in the Busseron Creek watershed.

8.2.2 Nutrient Management Plans

Nutrient management plans are often implemented to help maximize crop yields while using nutrient resources in the most efficient, environmentally sound manner. The plans help guide landowners by analyzing agricultural practices and suggesting appropriate nutrient reduction techniques. This is often done by managing the amount and timing of nutrient fertilizers on agricultural land in the watershed. Nutrient management plans are tailored for specific fields and crops. Because of this, they require site specific sampling and planning. USEPA (1993) suggests that the nutrient management plan include:

- Maps and data regarding the farm size and type of crops grown
- Realistic yield expectations based on soils and past crop yields
- Summary of the nutrient resources available
- An evaluation of field limitations and hazards
- Use of the limiting nutrient concept to apply nutrients based on realistic crop expectations
- Specific timing and application data for nutrients
- Provisions for proper calibration and operation of nutrient application equipment
- Annual reviews and monitoring

Using these plans, a landowner can apply fertilizers based on the limiting nutrient in the soils and realistic crop yields.

Limited information is available on the effectiveness of nutrient management plans to reduce loads of phosphorus. The effectiveness will vary a great deal depending on the application rate prior to implementation of the plan and site-specific factors such as crop types and soil characteristics.

Landowners/operators should contact their local soil and water conservation district to obtain information about obtaining funding.

8.3 Septic Systems

Septic systems provide an economically feasible way of disposing of household wastes where other means of waste treatment are unavailable (e.g., public or private treatment facilities). The basis for most septic systems involves the treatment and distribution of household wastes through a series of steps involving the following:

- A sewer line connecting the house to a septic tank
- A septic tank that allows solids to settle out of the effluent
- A distribution system that dispenses the effluent to a leach field
- A leaching system that allows the effluent to enter the soil

Septic system failure occurs when one or more components of the septic system do not work properly and untreated waste or wastewater leaves the system. The waste may pond in the leach field and ultimately run off into nearby streams or percolate into the groundwater system. Untreated septic system waste is a potential source of nutrients, organic matter, suspended solids, and bacteria. The most common reason for failure is improper maintenance. Other reasons include improper installation, location, and choice of system. Harmful household chemicals can also cause failure by killing the bacteria that digest the waste.

Many homeowners do not realize they have a failing septic system, whereas others may know, but choose not to remedy the problem because of cost. One recommendation is to initiate an outreach program to educate residents about septic systems, and, in some cases, provide funding to help fix or replace failing systems. The components of an example outreach program are illustrated below:

- Make homeowners aware of the age, location, type, capacity, and condition of their septic system.
- Teach homeowners to recognize a failing septic system.
- Teach homeowners about proper septic system maintenance.
- Provide information about different types of septic systems, and their costs, advantages, and disadvantages.
- Provide consultation and inspection services to homeowners.
- Teach homeowners about water quality concerns in their watershed.

In addition to conducting a public outreach campaign, an effort should be made to identify and repair failing systems. In some cases extremely old systems might need to be replaced. Systems located in close proximity to streams impaired by nutrients should be targeted first. This effort should be coordinated by the appropriate county health department.

Finally, an effort needs to be made to ensure that septic systems are properly maintained. Homeowners should be required to pump out or inspect their septic tanks on a regular schedule. Septic tanks should be pumped when the solids in the tank accumulate to a point where the effluent no longer has enough time to settle and clarify. The timing of the pump-out depends on the tank and household size.

8.4 Monitoring Plan

Future monitoring of the Busseron Creek watershed will take place during IDEM’s five-year rotating basin schedule and/or once TMDL implementation methods are in place. Monitoring will be adjusted as needed to assist in continued source identification and elimination. IDEM will monitor at an appropriate frequency to determine if Indiana’s water quality standards are being met. When these results indicate that the waterbody is meeting the water quality standards, the waterbody will then be removed from the 303(d) list.

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